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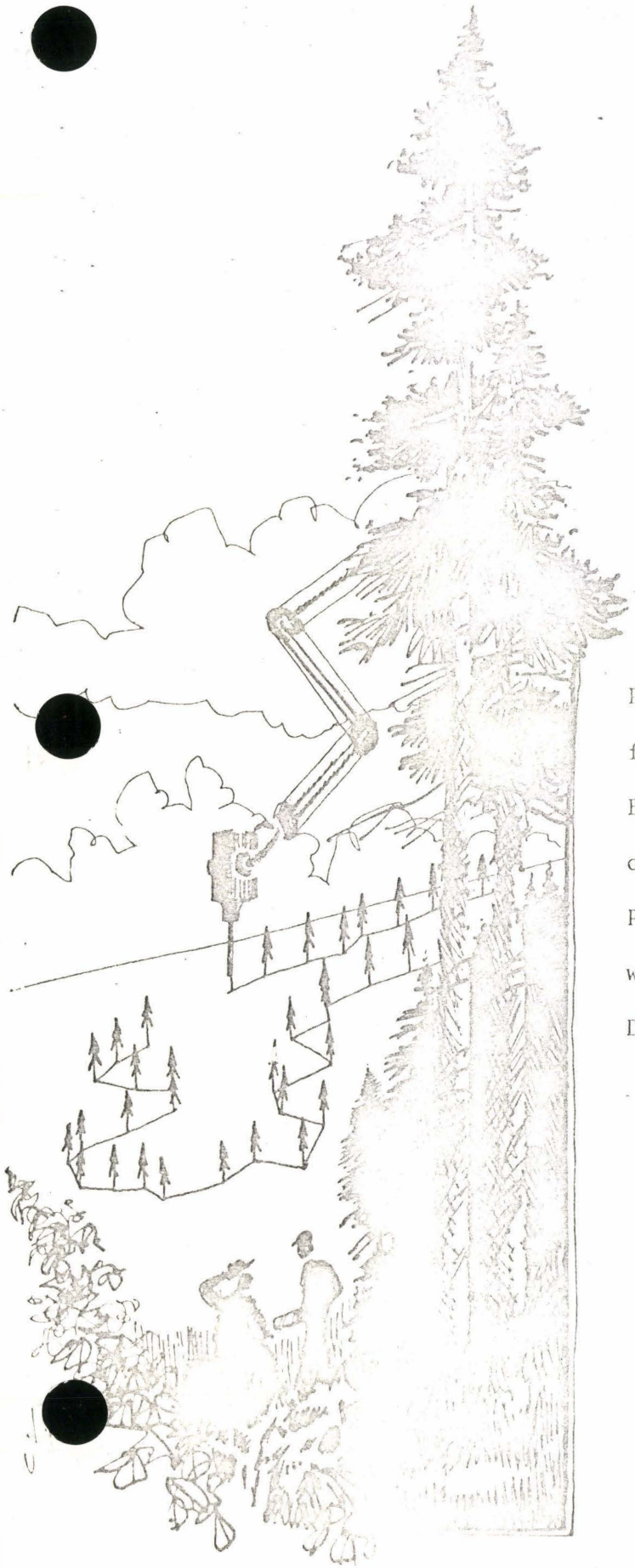

PERSPECTIVE PLOT PROGRAM

for

EVALUATING VISUAL IMPACT

of

PROPOSED TIMBER HARVEST UNITS

with

DESK TOP CALCULATOR, PLOTTER AND DIGITIZER

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PERSPECTIVE PLOT WITH DESK TOP CALCULATOR, PLOTTER AND DIGITIZER

Abstract

Discusses the general application of this technique related to shaping clear-cut units. The technique is related to the landscape architect and logging specialist disciplines for planning harvest units to conform with the objectives outlined in the Visual Management System (U.S.D.A. Handbook 462) adopted by the Forest Service. Detailed operating instructions and program listing is provided for use on the Hewlett-Packard 9830 with peripherals. Finally, a simplified mathematical explanation of the computer program is given to provide a foundation for converting this technique to operate on any desk top computer that is interfaced with plotter and digitizer.

1.0 INTRODUCTION

During the past decade, public concern over timber harvest practices has increased. Objections have been raised concerning a wide range of these practices. Among the concerns has been the clearcutting issue. The case against clearcutting includes various points ranging from valid scientific concerns to objectives pertaining to the appearance of clearcut units. To some, they appear as devastation and destruction, to others the remaining slash bears wasteful of the wood resource, while others feel there is unacceptable damage to soil and water resources. It is nearly impossible to design units to alleviate everyone's concerns particularly in the area of aesthetics. However, in general the closer clearcut units emulate the natural characteristics of their surroundings, the less objectionable they will be.

The U.S. Forest Service has developed guidelines for determining the aesthetic importance of various landscapes, as well as timber sale layouts to retain or create desirable characteristics. Once the aesthetic importance has been determined and the natural landscape character is identified, the job then becomes one of determining size, shape, edge effect, and location of sale units in a coordinated effort between landscape architects and logging system specialists.

When the landscape's natural visual characteristics are one of continuous timber cover, clearcuts must be at least partially hidden to maximize the continuous texture appearance. Where the landscape is one of scattered natural openings, clearcuts need only to repeat those same size, shape, and edge characteristics in full view. However, analytical methods are needed to predetermine exactly what a proposed clearcut unit will look like after it is cut. Such a method should enable the layout crews to mark out clearcut boundaries with assurance that the cut unit will conform to the shape the landscape architect intended. Also, the method should permit the architect and the logging specialist to experiment with various layouts and find an acceptable compromise between aesthetics and economy.

This report documents one analytical method that provides this capability. A desk-top calculator with digitizer and plotter are the hardware items needed for this analysis. These desk-top systems are presently on many National Forests. Detailed operating instructions, and a program listing will be provided for use of this analysis with a Hewlett-Packard 9830 desk-top system. Finally, an explanation of the basic mathematics will be provided to serve as guide for programming any equivalent desk-top system for this analysis.

Essentially, the output of this analysis is a true scale perspective projection of the proposed cutting unit. The boundary of the unit is drawn in straight line segments, and the boundary trees and crowns plotted at true visual scale. (See Figure 1 for sample output.) Ridge lines can also be plotted to show the positioning of the units in relation to the horizon.

The necessary data base for the input is simply a contour map including the viewing point with the cutting unit outlined (see Figure 2).

This method of perspective projection of clear-cut units is not the only one available. However, it has been well received because it utilizes computer speed and accuracy, but still has the interactive characteristics of direct problem solving. Arriving at a desirable solution for the visual design is essentially a trial and error process at best. This method allows the architect to experiment quickly with various boundaries and arrive at a suitable end product.

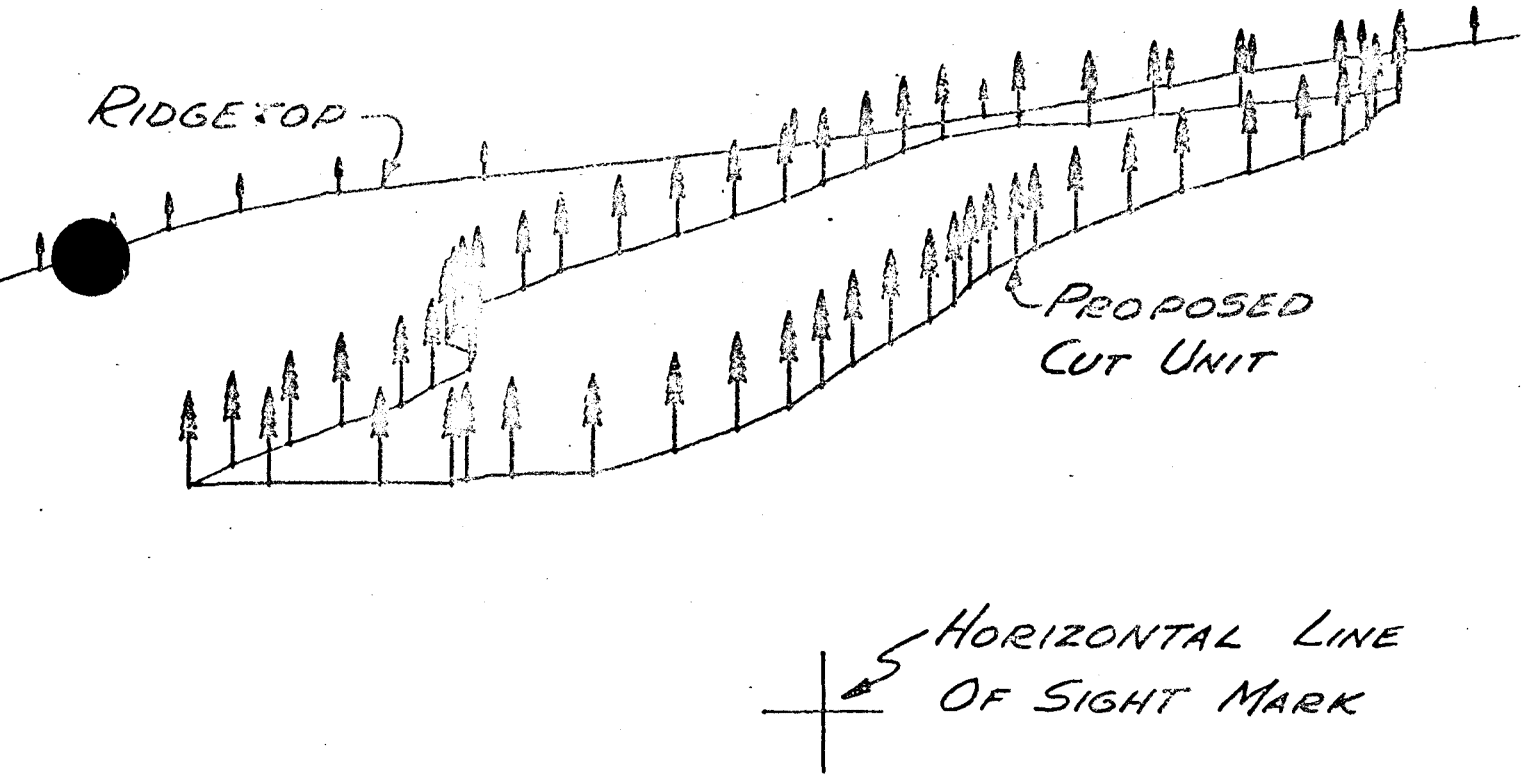


FIGURE 1

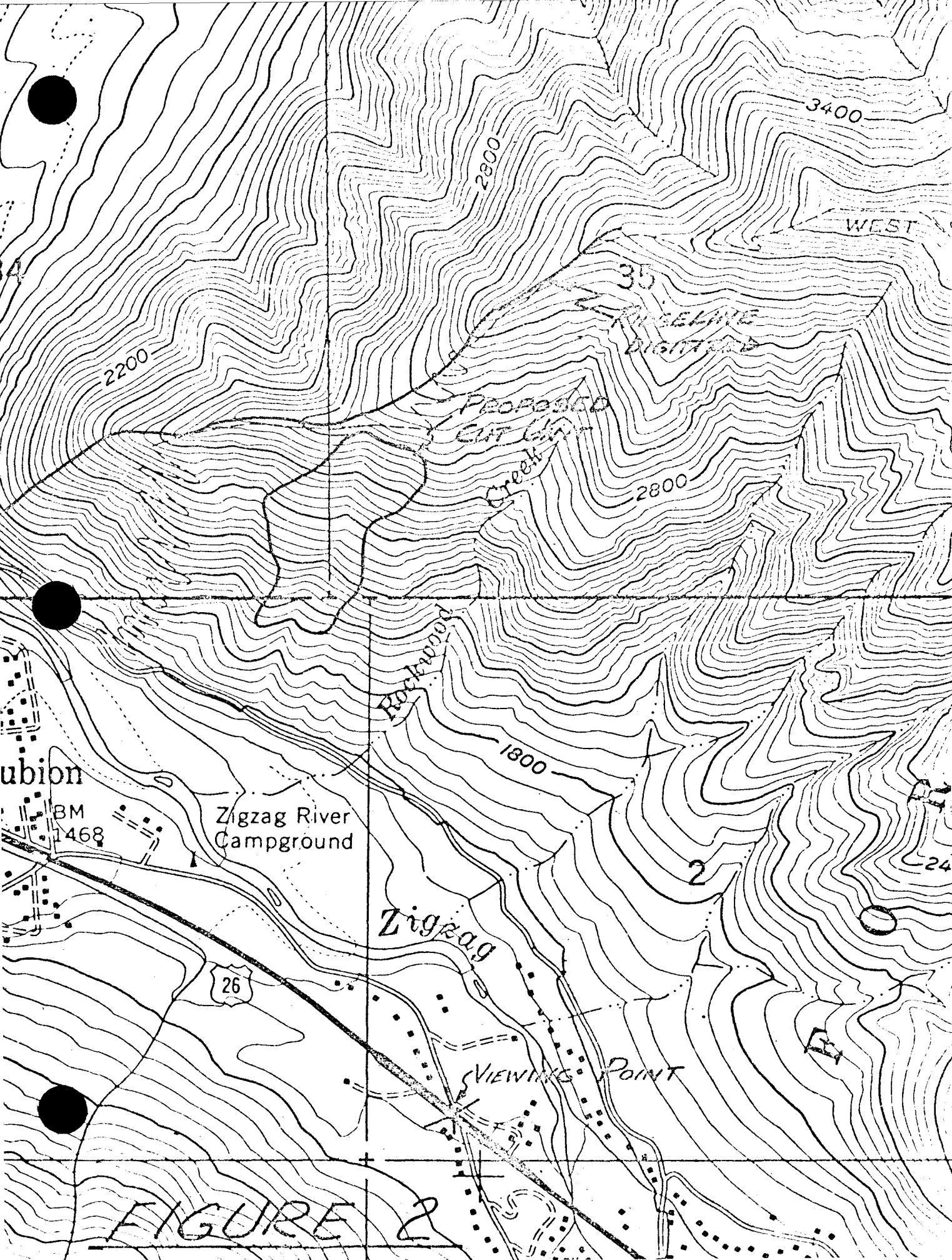

3400
2800
WEST
35
2200
Rockwood
Cut Off
Creek
2800
Rockwood
1800
ubion
BM
1468
Zigzag River
Campground
2
Zigzag
26
VIEWING POINT

FIGURE 2

DOCUMENTATION OF HEWLETT-PACKARD 9830 PROGRAM

Detailed user instructions and the program listing are given in this section to apply to use with computer systems programmable in the American Standard Code for Information Interchange (ASCII) BASIC language. They were developed on a Hewlett-Packard 9830 desk-top calculator/plotter/digitizer system.

2.1 INITIALIZATION

This program can be put on a magnetic tape cassette. The first file on the tape contains the program. The second file contains special function key listings which dovetail into the program, and are necessary for execution of the program. The first step in the use of these programs is

LOAD 0, EXECUTE

When loading is complete the ├— symbol appears in the Display.

Then load the special function keys by

LOAD KEY 1, EXECUTE

With the plotter and digitizer turned on, and the plotter pen set for range of the 15" x 10" plot sheet, the program is ready to operate.

2.2 INPUT DATA

All the input data is derived from a contour map base similar to FIGURE 2. This map must have the following data delineated:

1. Proposed clearcut unit(s) accurately outlined.
2. Critical viewing point(s) marked.
3. Ridge lines identified (or identifiable).

This map must be fastened to the digitizer surface to prevent it from slipping.

2.3 PROGRAM OPERATION

To commence operation of this program

RUN, EXECUTE

This program assists the user by requesting input in sequence through visual prompters in the Display. Some additional explanation of these displayed prompters is provided in Table 1.

TABLE 1 - Input Explanation for Perspective Plot Program

VISUAL PROMPTER ON DISPLAY	KEYBOARD RESPONSE	ADDITIONAL COMMENTS
Unit uphill of VP (Y for Yes, N for No)?	Y	The plotter draws level line of sight mark -|- to reserves the bulk of the plotting space above it if the units are uphill of viewing point, or visa versa.
Enter 18 for normal view, smaller# for wider view	18	See Figure 4 for explanation.
Map scale-feet/inch?	1320	No comment needed.
Contour Interval (feet)?	40	Enters the contour interval on the base map which will be digitized on unit's perimeter.
height in feet?	140	This should be varied as timber surrounding the unit(s) varies to ascertain the extent of screening which will occur from the viewing point.
Crown length as % of tree height?	40	Cosmetic feature which permits the plotting of the surrounding timbers crown size.
Crown width in feet?	25	Cosmetic feature which permits the plotting of the surrounding timbers crown size.

TABLE 1 - Input Explanation for Perspective Plot Program

VISUAL PROMPTER ON DISPLAY	KEYBOARD RESPONSE	ADDITIONAL COMMENTS
Digitize viewing point	digitize	1./ Center digitizer cursor cross hairs on the map point from which you wish to construct view of the proposed units (i.e., the viewing point). 2./ After digitizer emits a short beep, press [0] and then [S] buttons on the cursor.
Elevation of viewing point?	1600	Enter the interpolated elevation from the contour map of this viewing point.
Digitize 1st point on cut unit		1./ Using the template suggested in Figure 4, or good judgment, pick an initial point on one cutting unit centered so desired viewing field will not fall outside of plotting capability. 2./ Center cursor cross hairs near this point, preferably where a contour line intersects the proposed unit boundary. 3./ Press the [S] button on the digitizer cursor after hearing the beep.
Elevation of 1st point?	3520	Enter the contour line elevation of this point.

TABLE 1 - Input Explanation for Perspective Plot Program

VISUAL PROMPTER ON DISPLAY	KEYBOARD RESPONSE	ADDITIONAL COMMENTS
Select a slope and proceed	f_{1-4}	Press the special function key that corresponds with the contour line route which will initiate the unit boundary traverse. See Figure 5 for special function card guide.
(This may be either one of the f keys described below)		
Uphill	f_1	1./ After the digitizer beeps press the [S] button when the cursor cross hairs are centered on the countour line/unit boundary intersection immediately uphill of the last point digitized. 2./ Continue moving uphill, centering the cross hairs on the countour line/unit intersections, and pressing the [S] button after each beep. 3./ Note that the display flashes the elevation after each point is digitized. This is to provide a check for the operator.
When the proposed unit requires a change in slope *press STOP* *then the appropriate f key*		
Level	f_2	Operate in the same manner as the previously described f_1 key. The difference is that the elevation of all points digitized is held constant.

TABLE 1 - Input Explanation for Perspective Plot Program

VISUAL PROMPTER ON DISPLAY	KEYBOARD RESPONSE	ADDITIONAL COMMENTS
Downhill	f_3	Operate the same way as the f_1 key. However, this key subtracts the contour interval from the elevation of the previously digitized point (i.e., decrements the elevation.)
Fractional (+ Uphill; - Down)	f_4	1./ This key permits plotting of additional map points interpolated between contour lines. 2./ Care must be taken to continue plotting in this mode (i.e., don't change to UPHILL or DOWNHILL mode) until the elevation equals the elevation of a plotted contour line. Example: If the contour interval is 40', and the operator wants to plot 10' elevation increments downhill, enter -.25 and digitize 4 times at interpolated quarter points between quarter points between the contour lines.

Anytime it is required to change the tree heights or crown geometry

press STOP
then special function key f_5

TABLE 1 - Input Explanation for Perspective Plot Program

VISUAL PROMPTER ON DISPLAY	KEYBOARD RESPONSE	ADDITIONAL COMMENTS
New tree HT, crown length %, Width	f_5 90, 50, 15	1./ Program can be interupted at any time to make changes in the tree size. 2./ The program will continue operating with the same slope (up, down, or level) as before. 3./ If both a new tree size and slope change are required, first change the tree size, then press STOP again and press the special function key for the desired new slope, and continue digitizing.
When the plotting of an individual unit, ridge, or horizon is complete, and it is desired to plot an additional feature *press: STOP* *then special function key* f_6		
Mark new unit or ridge		This will be displayed for 1 second. The pen will lift, and the next message will be displayed.
Digitize 1st point on next unit		Center cross hairs on any initial countour line/unit intersection point on the new unit, and press the [S] button after hearing the digitizer's beep.
Elev. of 1st point on next unit?	4000	Enter the elevation from the contour map of the point digitized.
Select a slope and proceed	f_{1-4}	Press the special function key that corresponds with the contour line route which will initiate the unit boundary traverse, and proceed as previously described.

TABLE 1 - Input Explanation for Perspective Plot Program

VISUAL PROMPTER ON DISPLAY	KEYBOARD RESPONSE	ADDITIONAL COMMENTS
When all the units and pertinent features within the viewing field have been plotted a perspective plot of these points can be "seen" from a different viewing point by performing the following routine:		
	press: STOP then special function key	f_o
Digitize viewing point		Center cross hairs on the new viewing point, and press the [S] button after the digitizer beeps.
Elevation of viewing point?	1680	Enter the interpolated elevation from the contour map of the new viewing point.
Digitize 1st point on cut unit		1./ This gives the operator an opportunity to re-orient and balance the plot correctly from the new viewing point. 2./ Use the template suggested in Figure 4 for centering to pick the first point. Orient so all the points plotted in the initial plot are within the plot field for subsequent views.
Elevation of 1st point?		Enter the contour elevation of this point.
Plot complete		1./ Displayed when the previously digitized points are plotted as seen from the new viewing point. 2./ This process can be repeated from various other viewing points by repeating the STOP f_o commands. The f_o button may have to be pushed twice to get the initial visual display activated.

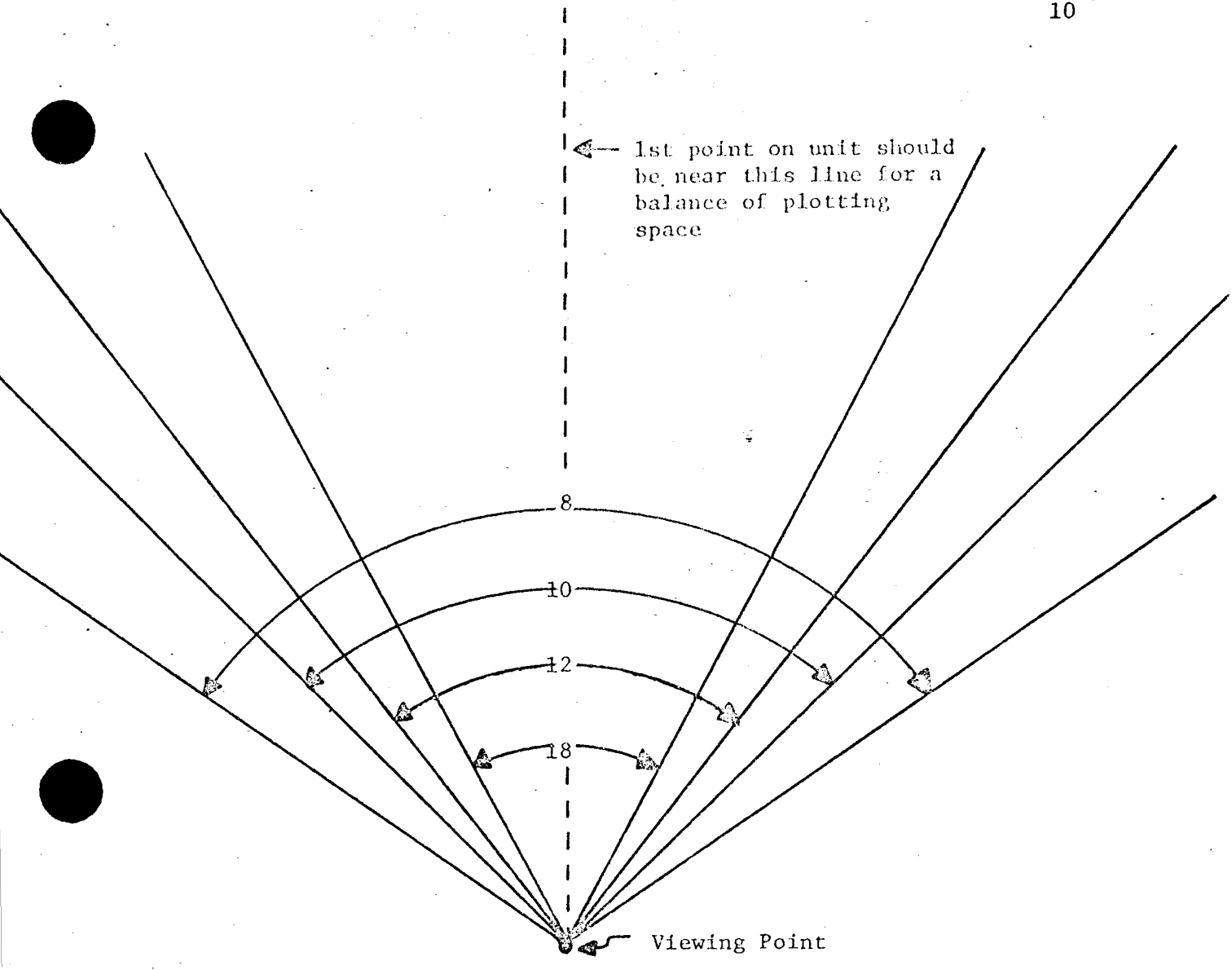


FIGURE 4

Focal Distance Response:

1. This establishes the plot size and width of viewing field attainable with the maximum 10 inch by 15 inch plotter limits established.
2. If 18 (inches) is entered, the plot will be constructed to appear at true viewing size if the plot is held 18 inches from the viewer's eye, and correspondingly for other values entered.
3. To use the program, construct a mylar overlay template as shown above to aid in centering the plot, and selecting a focal length value that will enable the entire field of digitized data to be included on one plot. Or it may be the program user will want to have the view constructed at a larger scale, and use 2 or more plot sheets with some overlap plotted to obtain a larger scale and/or wider angle view. In any case the template will be advantageous for correct construction of these views.
4. The half angles measured for this template are:

   18 inch focal length = 22.6°
   12 inch focal length = 32.0°
   10 inch focal length = 36.9°
    8 inch focal length = 43.2°

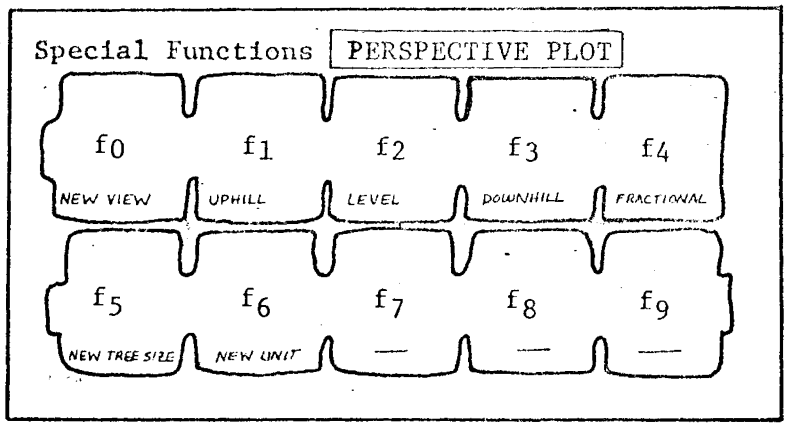


FIGURE 5 - SPECIAL FUNCTION CARD FOR PERSPECTIVE PLOT PROGRAM

PERSPECTIVE PLOT PROGRAM

There are eight program (the main program and seven brief entry subprograms) in the perspective plot computer/digitizer/plotter program. The listings are shown below for those who wish to use, or remodel the algorithms. The program as written requires 5167 words on the Hewlett-Packard 9830 calculator. With the 8K H.P. 9830 a 256x6 split precision matrix can be accommodated. The matrix is necessary for storing the tree size and map coordinates of each point for automatic replotting from a new viewpoint. The program would require revision to operate on the 4K Model of the 9830.

Listing of perspective plot program.

LISTING OF PERSPECTIVE PLOT PROGRAM

```
 010 DIM B$[30],R[256,6]
 20 H=9
 30 DISP "UNIT UPHILL OF VP<Y FOR YES N FOR NO)";
 40 INPUT B$
 50 IF B$="Y" THEN 80
 60 SCALE -7.5,7.5,-7.3
 70 GOTO 90
 80 SCALE -7.5,7.5,-3.7
 90 PLOT -0.3,0,-2
100 PLOT 0.3,0,-1
110 PLOT 0,0.3,-2
120 PLOT 0,-0.3,-1
130 DISP "ENTER  .8 FOR NORMAL VIEW,SMALLER # FOR WIDER VIEW";
140 INPUT D8
150 DISP "MAP SCALE-FEET/INCH?";
160 INPUT H
170 DISP "CONTOUR INTERVAL (FEET)?";
180 INPUT C
190 DISP "TREE HEIGHT IN FEET?";
200 INPUT K
210 DISP "CROWN LENGHT AS  % OF TREE HT.?";
220 INPUT R
230 DISP "CROWN WIDTH IN FEET?";
240 INPUT Q1
250 DISP "DIGITIZE VIEW'G PT."
260 WAIT 1000
270 WRITE (9,*)
280 ENTER (9,*)X1,Y1
290 DISP "ELEVATION OF VIEW'G PT.?";
300 INPUT Z1
310 IF N=1 THEN 330
320 N1=1
330 DISP "DIGITIZE 1ST PT.  ON CUT UNIT";
340 WAIT 1000
350 WRITE (9,*)
360 ENTER (9,*)X2,Y2
370 DISP "ELEVATION OF 1ST POINT?";
380 INPUT Z2
390 A(1,1)=X2
400 A(1,2)=Y2
410 A(1,3)=Z2
420 A(1,4)=R
430 A(1,5)=Q1
440 A(1,6)=K
```

```
450 X=X1-A[1,1]
460 Y=Y1-A[1,2]
470 DEG
480 A1=ATN(Y/X)
490 Z=A[1,3]-Z1
500 D1=SQR(X*X+Y*Y)*H
510 F=D8*(Z/D1)
520 PLOT 0,F
530 IF N1=1 THEN 1730
540 IF M=1 THEN 1190
550 DISP "SELECT A SLOPE AND PROCEED";
560 STOP
570 WRITE (9,*)
580 ENTER (9,*)X3,Y3
590 N1=N1+1
600 Z3=Z2+C1*C
610 DISP Z3
620 WAIT 1
630 A[N1,1]=X3
640 A[N1,2]=Y3
650 A[N1,3]=Z3
660 A[N1,4]=R
670 A[N1,5]=D1
680 A[N1,6]=K
690 X7=A[N1,1]-X1
700 Y7=A[N1,2]-Y1
710 Z7=A[N1,3]-Z1
720 IF X7=0 THEN 950
730 D7=SQR(X7*X7+Y7*Y7)*H
740 A7=ATN(Y7/X7)
750 A8=A1-A7
760 N=D8*TAN(A8)
770 V8=ATN(Z7/D7)
780 G=SQR(N*N+D8*D8)
790 V9=ATN((Z7+K)/D7)
800 L1=G*TAN(V8)
810 L2=G*TAN(V9)
820 PLOT N,L1,-2
830 PLOT N,L2
840 T1=(D1/K)*(L2-L1)
850 T2=(R/100)*(L2-L1)
860 IPLOT -T1+0.25,-T2+0.25,0
862 IPLOT T1+0.2,T2+0.05,0
864 IPLOT -T1+0.35,-T2+0.3,0
```

```
866 IPLOT T1+0.25,T2+0.05,0
868 IPLOT -T1+0.3,-T2+0.3,0
870 IPLOT T1+0.3,T2+0.05,0
872 IPLOT -T1+0.35,-T2+0.3,0
874 IPLOT T1+0.5,T2+0.1,0
876 IPLOT T1+0.5,-T2+0.1,0
878 IPLOT -T1+0.35,T2+0.3,0
880 IPLOT T1+0.3,-T2+0.05,0
882 IPLOT -T1+0.3,T2+0.3,0
884 IPLOT T1+0.25,-T2+0.05,0
886 IPLOT -T1+0.35,T2+0.3,0
888 IPLOT T1+0.2,-T2+0.05,0
890 IPLOT -T1+0.25,T2+0.25,0
910 PLOT W,L1
920 Z2=Z3
930 IF M=2 THEN 1700
940 GOTO 570
950 X7=0.01
960 GOTO 730
970 DISP "UPHILL"
980 WAIT 1000
990 C1=1
1000 GOTO 570
1010 DISP "LEVEL SLOPE"
1020 WAIT 1000
1030 C1=0
1040 GOTO 570
1050 DISP "DOWNHILL"
1060 WAIT 1000
1070 C1=-1
1080 GOTO 570
1090 DISP "FRACTIONAL (+UPHILL,-DOWN)";
1100 INPUT C1
1110 GOTO 570
1120 DISP "NEW TREE HT,CROWN LENGTH%,WIDTH";
1130 INPUT K,R,Q1
1140 GOTO 570
1150 M=1
1160 PEN
1170 N2=N1
1180 GOTO 250
1190 FOR N1=1 TO N2
1200 X7=A[N1,1]-W1
1210 Y7=A[N1,2]-W1
1220 Z7=A[N1,3]-Z1
```

```
1230 IF X7=0 THEN 1810
1240 IF A(N1,3)=0 THEN 1500
1250 D7=SQR(X7+X7+Y7+Y7)+H
1260 A7=ATN(Y7/X7)
1270 A8=A1-A7
1280 W=09+TAN(A8)
1290 V8=ATN(Z7/D7)
1300 G=SQR(W+W+08+08)
1310 K=A(N1,6)
1320 V9=ATN((Z7+K)/D7)
1330 L1=G+TAN(V8)
1340 L2=G+TAN(V9)
1350 IF N1=2 THEN 1520
1360 PLOT W,L1,-2
1370 PLOT W,L2
1380 T1=((A(N1,5))/K)*(L2-L1)
1390 T2=((A(N1,4))/100)*(L2-L1)
1400 IPLOT -T1/4,-T1/4,0
1410 IPLOT -T1/4,-(T2-(T1/4)),0
1420 IPLOT T1,0,0
1430 IPLOT -T1/4,(T2-(T1/4)),0
1440 IPLOT -T1/4,T1/4,0
1450 PLOT W,L1
1460 NEXT N1
1470 PEN
1480 DISP "PLOT COMPLETE"
1490 STOP
1500 PEN
1510 NEXT N1
1520 PEN
1530 GOTO 1360
1540 DISP "PLOT COMPLETE"
1550 STOP
1560 DISP "MARK NEW UNIT OR RIDGE"
1570 WAIT 1000
1580 N1=N1+1
1590 A(N1,3)=A(N1,2)=A(N1,1)=0
1600 PEN
1610 DISP "DIGITIZE 1ST PT ON NEXT UNIT";
1620 WAIT 1000
1630 WRITE (9,*)
1640 INPUT (9,*)X3,Y3
1650 DISP "ELEV OF 1ST PT ON NEXT UNIT?";
```

```
1660 INPUT Z3
1670 N1=N1+1
1680 M=2
1690 GOTO 630
1700 M=0
1710 DISP "SELECT A SLOPE AND PROCEED"
1720 STOP
1730 N1=N1+1
1740 A(N1,1)=A(1,1)
1750 A(N1,2)=A(1,2)
1760 A(N1,3)=A(1,3)
1770 A(N1,4)=A(1,4)
1780 A(N1,5)=A(1,5)
1790 A(N1,6)=A(1,6)
1800 GOTO 540
1810 X7=0.01
1820 GOTO 1240
```

PROGRAM ON f_0 KEY

CONT 115Ø

PROGRAM ON f_1 KEY

CONT 97Ø

PROGRAM ON f_2 KEY

CONT 1Ø1Ø

PROGRAM ON f_3 KEY

CONT 1Ø5Ø

PROGRAM ON f_4 KEY

CONT 1Ø9Ø

PROGRAM ON f_5 KEY

CONT 112Ø

PROGRAM ON f_6 KEY

CONT 156Ø

3.0 MATHEMATICAL EXPLANATION

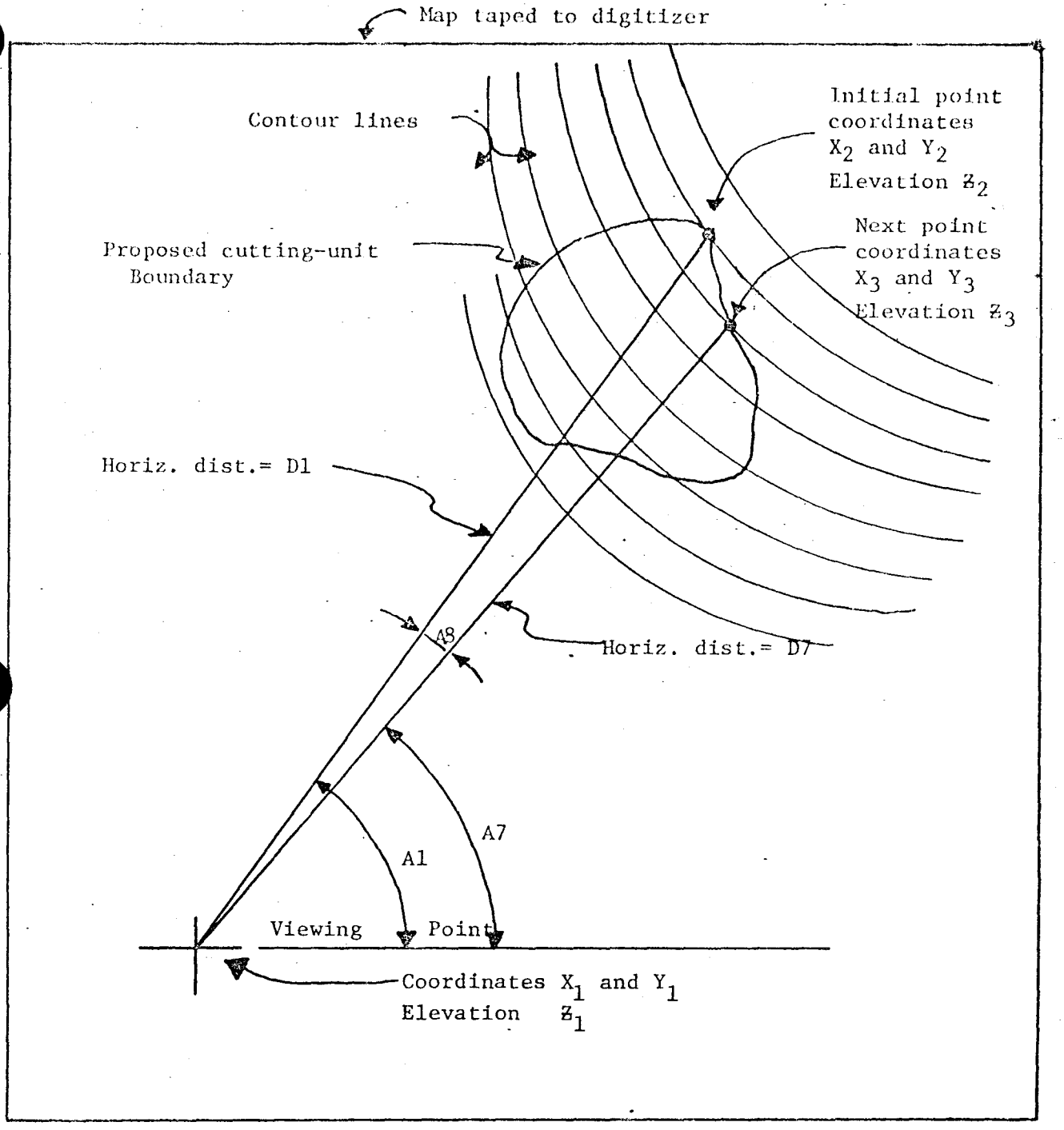
The foundation for this analysis can be briefly described as relating solved horizontal and vertical angles from contour map input to plotted diagram where the viewing is calculated at a fixed distance from the diagram. That distance will be assumed to be 18.0 inches for this example. However, it can be varied if the designer wants to include a larger or smaller field width within a limited plot size.

Refer to Figure 3 for a sequential explanation of the program's operation on entered analyzed data.

Throughout this explanation, it is assumed that the desk-top's digitizer and plotter both read coordinates and plot directly in inches. If this is not the case a correcting scale conversion statement must be made within the program.

1. Tape contour map to digitizer surface.
2. Get plotter to mark point near the center of the sheet for horizontal line of site. A $+$ symbol is used in the H.P. 9830 program. If the plot size is limited the mark should be made nearer the bottom of sheet if the viewing area is at a higher elevation than the viewing point, and visa versa.

3. Enter and store: H (map scale in feet/inch)
4. Enter and store: K (tree height in feet)
5. Enter and store: Digitized coordinates of the viewing point x_1 and y_1
6. Enter and store: Elevation in feet of the viewing point Z_1



X AXIS (Digitizer Coordinates)

FIGURE 3

7. Choose and mark initial near the viewing center of the clearcut unit where a contour line crosses the unit boundary.

8. Enter and store: Digitized coordinates of the initial point x_2 and y_2

9. Enter and store: Elevation of initial point Z_2

(COMPUTER NOW CALCULATES PLOT COORDINATES FOR THIS INITIAL POINT BY FOLLOWING PROCESS.)

I. Calculate horiz. distance from Viewing point to Initial Point

a. $X = X_2 - X_1$

b. $Y = Y_2 - Y_1$

c. $D1 = (X^2 + Y^2)^{\frac{1}{2}}H$

D1- True distance in feet from View Point to Initial point

II. Calculate Azimuth angle from viewpoint to initial point

a. $A1 = \text{Arc Tan } y/x$

III. Calculate Values to be plotted at initial point

a. $Z = Z_2 - Z_1$

b. $F = 18\ Z/D1$

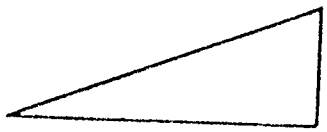
F= Plot value in inches to ground line of initial point

and

$F1 = 18\ (Z + K)/D1$

F1= Plot value in inches to tree top at initial point

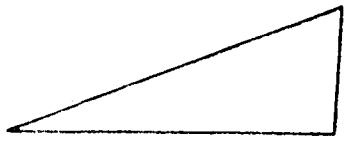
These F & F1 values can be derived on the basis of proportionate triangles, i.e.,



Z true elevation difference

D1= true horiz. dist (view pt. to initial point)

and



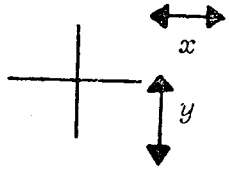
F= plot distance above horizontal line of sight

18" distance (viewer distance from plot diagram)

and likewise for the F1 value

IV. To plot the values now calculated for the initial point:

a. Origin must be set at horizontal line of site mark.



plot coordinate= 0.00

plot coordinate= 0.00

b. The following plot commands are needed:

(LIFT PEN)

PLOT O (x coord.), F (y coord.)

(which plots to base of tree @ initial pt.)

PLOT O, F1

(plots to top of tree that is K height)

PLOT O, F

(returns plotter to base of tree)

---

10. Input additional data needed to generate plot for the next point adjacent to the initial point.

11. Enter and store: Digitized coordinates of the next point x_3 and y_3

. Enter and store: Elevation of next point Z 3

(COMPUTER NOW CALCULATES PLOT COORDINATES FOR THE NEXT POINT BY THE FOLLOWING PROCESS)

I. *Calculate Distance from Viewing Point to Second point*

a. $X7 = X3 - X1$

b. $Y7 = X3 - X1$

c. $D7 = (X7^2 + Y7^2)^{1/2}$ II

II. *Calculate azimuth angle from view point to second point*

a. $A7 = \text{Arc Tan } Y7/X7$

III. *Calculate azimuth angle difference between initial point and second point*

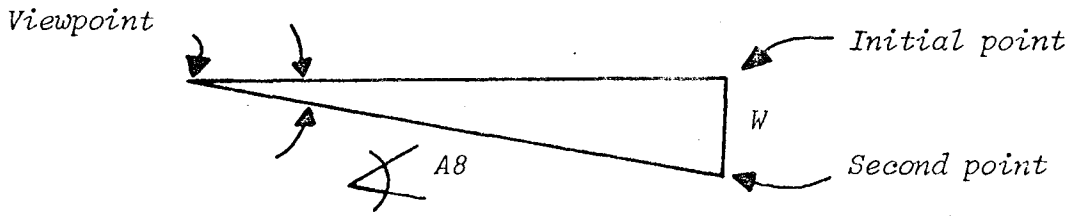
a. $A8 = A1 - A7$

IV. *Calculate "x" value to be plotted*

a. $W = 18 \text{ Tan } A8$

w= "x" value to be plotted

(based on Triangular relationship)



V. *Calculate "y" values to be plotted*

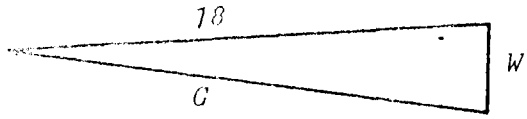
a. $V8 = \text{Arc Tan } Z7/D7$

and

$V9 = \text{Arc Tan } (Z7 + K)/D7$

b. $G = (W^2 + 18^2)^{1/2}$

G= Horizontal Distance from eye to "X" projection of second plotted point.



c. *L1= G Tan V8*

L1= "y" coordinate to plot for base of tree

and

L2= G Tan V9

L2= "y" coordinate to plot for top of tree

VI. To plot the values now calculated for the second point the following plot commands are needed:

(Pen down to draw line from initial point to second point)

- *PLOT W, L1*

  (which move plotter to base of tree at second point)

- *PLOT W, L2*

  (move plotter to top of tree at second point)

- *PLOT W, L1*

  (move plotter back to base of tree at second point)

---

13. Repeat steps 11 and 12 for each additional point you need to plot.

The computer must cycle through the same calculations for each additional point plotted. The base or reference line is always established from the data established by plotting the viewing point and the initial point.

If several clear-cut units are to be seen from one viewing point it is desirable to lift the pen up either manually or through program control as plotter moves from one point to the next. This is also true if ridge tops are outlined.

Most desk-top systems can be programmed to automatically calculate the elevation at each plotted point except for the initial one. This time saving modification requires entering and storing the contour line interval in feet; and arranging a technique to signal the program for going downhill (decrimenting elevation), going uphill (incrementing elevation), or going level (holding elevation constant).